TURFGRASS

&

LANDSCAPE MANAGEMENT

FIELD DAY

September 18, 2001

University of California, Riverside
Cooperative Extension
Dept. of Botany and Plant Sciences
Agricultural Operations

TURFGRASS AND LANDSCAPE MANAGEMENT FIELD DAY
TUESDAY, SEPTEMBER 18, 2001

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GREEN WASTE COMPOST AS A TURF SOIL AMENDMENT

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Turfgrass areas may become a larger user of green waste compost thereby diverting the material from landfills. Soil amending with green waste compost is one method that can be utilized and potentially benefit turfgrass. However, the optimum level of amendment is not known for the beneficial effects of amending with compost. The objective of this study is to bracket the optimum beneficial amendment volume for growing bermudagrass, and using it as a sports field, in a sandy loam soil.

Composted green waste was incorporated into the top 4 inches of the soil in early August 2000 at 3 rates (4, 8, and 12 yd^3 per 1000 ft^2). An unamended control was included. Arizona common bermudagrass was seeded 2 weeks later. Simulated sports traffic began in May 2001; three simulator passes are applied every two weeks. Irrigation is applied at about 80% of reference ET. Run time adjustments are made at least monthly. Fertilizer is applied every 6 weeks for a total of 5 lbs. N per 1000 ft^2 per year.

Turf quality, surface hardness, turf growth and surface elevations are measured regularly. Disease, color uniformity and other measurements are gathered as needed.

<u>Preliminary Results</u>

Preliminary data suggest that turf quality is improved only slightly, if at all, with the amendment treatments. More data is needed for a better understanding of a multi-year effect.

- *Turf quality is improved only slightly, if at all, with amendments.*

Prior to the traffic being imposed, turf quality was low, but acceptable. After traffic began, turf quality improved (likely due to seasonal growth patterns) but was still low, with no significant differences among amendment treatments. It was found at this preliminary stage that traffic only slightly decreased quality within each amendment treatment.

N ↑

3 -T	3 +T	1 +T	1 -T	3 -T	3 +T
4 -T	4 +T	3 +T	3 -T	1 -T	1 +T
1 -T	1 +T	2 +T	2 -T	2 -T	2 +T
2 -T	2 +T	4 +T	4 -T	4 -T	4 +T

3 -T	3 +T	4 +T	4 -T	1 -T	1 +T
4 -T	4 +T	2 +T	2 -T	3 -T	3 +T
1 -T	1 +T	1 +T	1 -T	2 -T	2 +T
2 -T	2 +T	3 +T	3 -T	4 -T	4 +T

1 4 yd^3 per 1000 ft^2
2 8 yd^3 per 1000 ft^2
3 12 yd^3 per 1000 ft^2
4 control

+T simulated traffic
−T no traffic

- *The field surface is softer with amendments, to a point.*

It was found that there were differences in surface hardness. Generally, as amendments are increased, the surface softens, although there is no difference between 8 and 12 yd^3 amendment per 1000 ft^2. There is a slight but insignificant increase in hardness with traffic among each treatment.

- *Amending soil with compost increases root mass.*

Amending the soil with composted green waste increased total plant mass, but the effect was not significant until 12 yd^3 had been incorporated. There was more turf root mass with 12 and 8 yd^3 when compared with the no amendment treatment and slightly more with 4 yd^3 amendment rate. Traffic led to a slight decrease in total mass.

Funding for this study was allocated from the University of California Division of Agricultural and Natural Resource. Also support has been provided by *California Biomass*, *Inland Composting and Organic Recycling*, and UCR Agricultural Operations.

DIAGNOSING ABIOTIC AND ENVIRONMENTAL PROBLEMS IN LANDSCAPES

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It is estimated that more than 80 percent of diagnosed disorders of landscape ornamentals are the direct or indirect result of adverse environmental and abiotic conditions rather than actual pathogens. Growing healthy trees, shrubs, and groundcovers requires: selecting a suitable species and cultivar for a given climate and microclimate; incorporating recommended planting measures; providing an adequate soil environment for optimal root growth; properly managing cultural practices (irrigation, fertilization, pruning, etc.); and, identifying and correcting disorders in a timely way.

Southern California soils are generally alkaline, resulting in high pH conditions, sometimes leading to unavailable micronutrients, such as iron, zinc and manganese. These nutrients are often found in adequate quantities in the rhizosphere, but are unavailable due to soil chemistry under high pH conditions. Therefore, when soil tests are conducted for diagnostic purposes, pH tests are a necessary part of the overall diagnostic process. Otherwise, these micronutrient deficiencies will not be detected. Often, applying sulphur to soils showing micronutrient deficiencies will acidify an alkaline soil rendering the once unavailable nutrients available to the plant.

A problem facing many southern California arborists is compacted soils with poor structure and drainage. Drainage must be improved and hardpans eliminated for proper root growth. This may require backhoeing or augering. Adding organic matter soil amendments to planting holes of trees is not recommended and may result in circled and girdled roots and eventually, hazardous trees prone to breakage and failure. Planting trees too shallow or too deep are other common problems. Planting too deep encourages root and crown disorders and planting too shallow can lead to root damage from exposure and excessive drying.

If staking is necessary, trees should be allowed to flex and not be tied in a rigid stance. Staked trees that are not allowed to flex will not develop strong lower trunks, resulting in a decreased ability to withstand heavy wind. The International Society of Arboriculture and other tree care organizations encourage the use of reputable pruning standards to help insure the development of healthy, safe trees that provide maximum environmental benefits.

Irrigating trees based on their evapotranspiration needs is often a major component in avoiding abiotic and biotic disorders. In general, young newly planted trees require more frequent irrigation due to maturing root zones, while mature specimen trees should be watered more deeply and infrequently.

Controversy has always surrounded the issue regarding routine fertilization of landscape trees. Some studies indicate no increased in growth when fertilizers are added, while many professionals recommend fertilizing landscape trees as soon as they are planted. In general, most healthy, mature, established trees require little fertilizer, which can be added when deficiency symptoms occur. Fertilizer, especially nitrogen, is often beneficial to promote more rapid growth and faster establishment of newly planted trees.

DRY DOWN RESPONSE OF TURFGRASS SPECIES AND CULTIVARS

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Four NTEP studies have been conducted at UCR. Three of the studies, the buffalograss, zoysiagrass and tall fescue trials, concluded on December 31, 2000 while the bermudagrass study will remain active through 2001. The results of the three concluded studies are being compiled and will be released soon. In the meantime, cultivar performance results can be obtained from NTEP at the following website: www.ntep.org

On June 1, 2001 all irrigation to the zoysiagrass, buffalograss and tall fescue studies was shut off, and the studies were allowed to go without any supplemental water until August 15, 2001. At that time, irrigation was resumed and greenup of the cultivars and species was recorded. Turfgrass performance on September 18, 2001, indicates the capability of cultivars of zoysiagrass, buffalograss and tall fescue to recover from a serious drought episode.

1996 NTEP BUFFALOGRASS TEST
Est. 29 July 1996

5	3	2	1	4	10	9
13	6	11	14	8	7	12
1	2	3	5	4	13	10
14	11	8	7	12	9	6
4	1	5	2	3	11	8
10	9	12	6	13	7	14

Seeded
1. CODY
2. TATANKA
3. BAM-1000
4. BISON
5. TEXOKA

Vegetative
6. 91-118
7. 86-120
8. 86-61
9. BONNIE BRAE
10. MIDGET
11. STAMPEDE
12. UC-95
13. 609
14. 378

1996 NTEP ZOYSIAGRASS TEST
Est. 29 July 1996

9	12	14	15	11	10	13	16
1	6	5	8	3	18	19	17
XXX	7	2	13	14	18	12	16
3	8	15	10	17	11	19	9
XXX	1	6	2	7	5	YZ3	YZ7
8	3	XXX	5	1	2	6	7
18	14	16	10	17	9	12	19
					13	11	15

<u>Seeded</u>
1. ZEN 500
2. ZEN 400
3. ZENITH
5. J 37
6. CHINESE COMMON
7. Z 18
8. KOREAN COMMON

<u>Vegetative</u>
9. DALZ 9601
10. J 14
11. MIYAKO
12. HT 210
13. DE ANZA
14. VICTORIA
15. EL TORO
16. JAMUR
17. ZEON
18. MEYER
19. EMERALD

1997 NTEP BERMUDAGRASS TRIAL

established 30 June 1997

Varieties 1-18 and 29 are seeded, 19-28 are vegetative

29	4	5	1	6	11	17	18
14	13	3	12	8	7	2	9
17	7	4	15	18	10	16	15
8	2	11	14	9	5	13	29
1	4	6	10	16	3	1	12
3	12	15	13	8	18	14	11
6	29	9	17	16	2	7	10
X	X	X	X	X	X	X	5
22	27	26	23	24	28	X	X
25	20	19	21	20	27	22	25
19	21	23	28	24	26	19	21
24	27	26	22	20	25	28	23

1 Savannah
2 2PST-R69C
3 Princess
4 SW 1-7
5 SW 1-11
6 Jackpot
7 Sundevil II
8 J-540
9 J-1224
10 Shangri La
11 Mirage
12 Pyramid
13 Majestic
14 OKS 95-1
15 Blue-Muda
16 Blackjack
17 Sahara
18 AZ Common
19 Mini-Verde
20 Shanghai
21 CN 2-9
22 OKC 18-4
23 OKC 19-9
24 Cardinal
25 Tift 94
26 Midlawn
27 Tifway
28 Tifgreen
29 Panama

1996 NTEP TALL FESCUE TRIAL

est. --Oct. 1997

plot size = 3.5'E-Wx7'N-S

56	76	93	98	99	5	36	71	31	52	16	64	33	1	73	87
80	79	22	38	21	102	55	48	86	45	103	51	59	78	49	112
82	100	96	125	14	97	20	23	111	32	90	92	128	114	122	12
118	4	58	117	109	75	41	28	13	127	123	66	15	50	65	101
29	106	34	24	107	69	95	110	108	120	35	62	94	81	84	37
77	129	115	2	11	10	57	74	42	72	91	39	61	104	44	47
68	46	116	25	54	9	7	119	8	70	3	85	53	40	6	124
27	18	88	19	121	43	126	30	26	63	113	83	17	105	60	89
67	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
128	129	29	118	60	61	20	8	82	59	6	5	125	115	89	67
70	49	106	80	84	102	72	117	43	40	123	47	122	121	25	56
76	124	78	65	2	103	90	36	21	32	68	104	126	28	99	33
114	54	66	42	14	13	15	129	4	83	111	100	57	81	97	44
27	64	19	7	69	55	116	58	17	92	31	96	48	22	46	23
39	105	120	62	51	79	127	24	75	95	34	74	12	107	11	37
91	77	86	3	41	128	52	18	108	113	63	30	1	88	53	73
101	71	9	45	85	26	10	98	112	16	110	87	109	93	119	50
94	35	38	X	X	X	X	X	X	X	X	X	X	X	X	X

1996 NATIONAL TALL FESCUE TEST - ENTRIES AND SPONSORS

Entry #	Name	Sponsor	Entry #	Name	Sponsor
1	ATF-192	Advanta Seeds West, Inc.	66	Marksman	E. F. Burlingham & Sons
2	ATF-196	Advanta Seeds West, Inc.	67	Renegade	E. F. Burlingham & Sons
3	ATF-022	Advanta Seeds West, Inc.	68	Southern Choice	E. F. Burlingham & Sons
4	ATF-038	Advanta Seeds West, Inc.	69	Falcon II	Standard Entry
5	ATF-182	Advanta Seeds West, Inc.	70	BAR FA6 US6F	Barenbrug USA
6	ATF-020	Advanta Seeds West, Inc.	71	Duster	Pennington Seed Company
7	ATF-253	Advanta Seeds West, Inc.	72	Cochise II	Ampac Seed Company
8	ATF-257	Advanta Seeds West, Inc.	73	WRS2	Willamette Seed Company
9	Tulsa	Advanta Seeds West, Inc.	74	WX3-275	Willamette Seed Company
10	Regiment	Advanta Seeds West, Inc.	75	Crossfire II	Pickseed West, Inc.
11	AA-A91	Lofts Seed, Inc.	76	Pick GA-96	Pickseed West, Inc.
12	AA-989	Lofts Seed, Inc.	77	Pick FA N-93	Pickseed West, Inc.
13	AA-983	Lofts Seed, Inc.	78	JTTFA-96	Japan Turfgrass II
14	CU9501T	Clemson University	79	JTTFC-96	Japan Turfgrass II
15	CU9502T	Clemson University	80	ISI-TF10	International Seeds, Inc.
16	Arid	Standard Entry	81	ISI-TF9	International Seeds, Inc.
17	J-98	Jacklin Seed Company	82	ISI-TF11	International Seeds, Inc.
18	J-3	Jacklin Seed Company	83	Kentucky-31 w/endo.	Standard Entry
19	DP 50-9011	DLF/ Trifolium	84	ZPS-5LZ	Zajac Performance Seeds, Inc.
20	DP 7952	DLF/ Trifolium	85	PST-5TO	Pure-Seed Testing, Inc.
21	J-5	Jacklin Seed Company	86	PST-5E5	Pure-Seed Testing, Inc.
22	Pixie E+	Jacklin Seed Company	87	PST-R5TK	Pure-Seed Testing, Inc.
23	Alamo E+	Jacklin Seed Company	88	PST-R5AE	Pure-Seed Testing, Inc.
24	J-101	Jacklin Seed Company	89	Gazelle	Zajac Performance Seeds, Inc.
25	Shortstop II	Pickseed West, Inc.	90	Safari	Turf-Seed, Inc.
26	Pick FA 15-92	Pickseed West, Inc.	91	Coyote	Zajac Performance Seeds, Inc.
27	Pick FA 6-91	Pickseed West, Inc.	92	Tomahawk-E	Turf-Seed, Inc.
28	R5AU	Rutgers University	93	Tarheel	Pure-Seed Testing, Inc.
29	LTP-4026 E+	Lebanon Turf Products, Inc.	94	Coronado	Turf-Seed, Inc.
30	Pennington-1901	Pennington Seed Company	95	Apache II	Turf-Seed, Inc.
31	TMI-RBR	Turf Merchants, Inc.	96	SS45DW	Smith Seed Services
32	TMI-FMN	Turf Merchants, Inc.	97	SSDE31	Smith Seed Services
33	TMI-N91	Turf Merchants, Inc.	98	Titan 2	Smith Seed Services
34	TMI-TW	Turf Merchants, Inc.	99	Lion	Cascade International Seed Co.
35	TMI-AZ	Turf Merchants, Inc.	100	EA 41	Cascade International Seed Co.
36	Bullet	Turf Merchants, Inc.	101	OFI-FWY	Olsen-Fennell Seed Co.
37	BAR FA 6D	Barenbrug Holland	102	OFI-951	Olsen-Fennell Seed Co.
38	BAR FA 6LV	Barenbrug Holland	103	OFI-931	Olsen-Fennell Seed Co.
39	Pick FA UT-93	Pickseed West, Inc.	104	Finelawn Petite	Finelawn Research, Inc.
40	Pick FA B-93	Pickseed West, Inc.	105	PSII-TF-10	Production Service International
41	Mustang II	Pickseed West, Inc.	106	PSII-TF-9	Production Service International
42	ATF-188	The Scotts Company	107	SRX 8500	Seed Research of Oregon, Inc.
43	TA-7	J. R. Koos & Sons	108	SRX 8084	Seed Research of Oregon, Inc.
44	WVPB-1B	Willamette Valley Plant Breeders	109	SR 8210	Seed Research of Oregon, Inc.
45	DLF-1	DLF/Trifolium	110	PRO 8430	Seed Research of Oregon, Inc.
46	OFI-96-31	Olsen-Fennell Seed, Inc.	111	Pick FA 20-92	Pickseed West, Inc.
47	OFI-96-32	Olsen-Fennell Seed, Inc.	112	Pick FA XK-95	Pickseed West, Inc.
48	EC-101	Emerald Commodities	113	Empress	Zajac Performance Seeds, Inc.
49	JSC-1	Jenks Seed Company	114	LTP-SD-TF	Lebanon Turf Products, Inc.
50	AV-1	Agrivesments	115	Leprechaun	Roberts Seed Company
51	PC-AO	Pratum Co-op	116	PST-5M5	Pure-Seed Testing, Inc.
52	RG-93	LESCO, Inc.	117	PST-5RT	Pure-Seed Testing, Inc.
53	WVPB-1D	Willamette Valley Plant Breeders	118	Jaguar 3	Standard Entry
54	WVPB-1C	Willamette Valley Plant Breeders	119	Pick RT-95	Pickseed West, Inc.
55	Koos 96-14	J. R. Koos & Sons	120	ZPS-2PTF	Zajac Performance Seeds, Inc.
56	MB 26	E. F. Burlingham & Sons	121	Sunpro	Pickseed West, Inc.
57	MB 28	E. F. Burlingham & Sons	122	Bonsai	Standard Entry
58	MB 29	E. F. Burlingham & Sons	123	PST-523	Pure-Seed Testing, Inc.
59	MB 210	E. F. Burlingham & Sons	124	BAR Fa6 US1	Barenbrug Research
60	MB 211	E. F. Burlingham & Sons	125	BAR Fa6 US2U	Barenbrug Research
61	MB 212	E. F. Burlingham & Sons	126	BAR Fa6 US3	Barenbrug Research
62	MB 213	E. F. Burlingham & Sons	127	BAR Fa6D USA	Barenbrug Research
63	MB 214	E. F. Burlingham & Sons	128	Shenandoah	Standard Entry
64	MB 215	E. F. Burlingham & Sons	129	Genesis	ProSeeds Marketing
65	MB 216	E. F. Burlingham & Sons			

OFFICIAL TEST

FERTILITY MANAGEMENT IN THE LANDSCAPE

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Proper nutrient management in landscapes is important to maintain the integrity and aesthetics of plant material while simultaneously preventing nutrient runoff into neighboring environments. Strict regulations regarding runoff water quality are being enforced for many agricultural sites such as nurseries and farming systems. High nitrate (NO_3) concentrations (>10 ppm NO_3-N) in runoff waters have become a major concern with respect to fertilizer usage. It is imperative that landscape installation and maintenance programs incorporate sound cultural and fertilization practices that will simultaneously optimize landscape quality and minimize the likelihood of fertilizer runoff.

There are <u>three goals</u> with regard to fertility management in agricultural-type systems:

1. Optimize plant performance (growth, quality).
2. Optimize fertilizer use efficiency.
3. Minimize/eliminate nutrient runoff.

To achieve the above goals, four areas of landscape management must be addressed:

1. Soil Preparation
2. Plant Selection
3. Fertilizer Management
4. Irrigation Management

<u>Soil Preparation</u>

**Soil Testing.* Always conduct a soil test when preparing a landscaped area. It is easier and less costly to correct chemical and physical problems of the soil before plants are installed.
**Drainage.* Adequate drainage is required. Poor drainage is often one of the primary causes of poor plant performance of landscapes. Plant roots are unable to take up water and nutrients in poorly drained soils.
**Water Holding Capacity*
  +*Sandy Soils* – Additions of organic matter will increase water holding and nutrient retention capacity of soils. This will improve irrigation and fertilization efficiency of the site.
  +*Clay Soils* - Heavy clays need to be amended to increase aeration for the root systems.
**pH.* A pH optimum of 6.5 to 7.5 is ideal for most crops. A pH of 5.0 to 6.0 is ideal for acid-loving plants such as ferns, camellia, azalea, and many other Ericaceous crops. In California, high pH is usually the reason for chlorosis of new foliage in azaleas and camellias.
**Fertility.* After a proper soil test, adjustments can be made to optimize the initial fertility status of the soil. This should be done prior to planting.
**Salinity.* High salinity will cause root necrosis in severe cases, limiting water and nutrient uptake. Salinity may be caused by poor drainage or over fertilization.
**Mulching.* Through proper mulching, water evaporation from soil is minimized.

Plant Selection

**Root System.* Select plants that are not root-bound in containers. If some root circling has occurred in containers, loosen roots to prevent continued circling once planted in the landscape.
**Root to Shoot Ratio.* Do not select plants with excessive shoot growth relative to roots. These plants will need frequent watering, which increases the likelihood of nutrient runoff from the landscape.
**Trunk Integrity.* Inspect trunks for any diseases or mechanical injury. Damaged trunks will inhibit water and nutrient uptake to shoots and carbohydrate translocation to roots.

Fertility Management

**Fertilization Method – Liquid vs. Granular.* Controlled Release Fertilizers offer slower release of nutrients over time. Nutrient availability in most formulations is based on temperature, with release rates increasing as temperature increases.
**Nutrient Balance*. The most important aspect of fertilization is nutrient balance. Many nutritional deficiencies are induced by over fertilization with a few essential nutrients (primarily nitrogen, phosphorus and potassium) without application of the other essential nutrients such as calcium, magnesium, etc. This occurs because not all bulk fertilizers contain all major essential elements in the relative proportions needed to optimize growth. Therefore, symptoms of calcium and especially magnesium deficiencies are occurring, through over fertilization with potassium and nitrogen. (See 'Nutrition Notes Handout' for a detailed description of nutrient deficiency and toxicity symptoms and the soil, environmental and cultural conditions that may be associated with these symptoms). These symptoms are evident in palms such as *Phoenix canariensis* and some dicots.
**Timing of Fertilizer Applications.* It appears that ornamentals take up the majority of nutrients after the flush of vegetative growth is reaching maturity not during the active growth of the flush. Therefore the best time for fertilizer application is in spring so that fertilizer is available as growth flushes begin maturing. Winter fertilization may result in nutrient runoff. The exception occurs for winter-growing shrubs and growth of cool-season annuals.

Irrigation Management

Next to fertilization programs, irrigation practices will have a major impact on the three objectives (plant performance, fertilizer use efficiency, and nutrient runoff). Irrigation practices will be addressed more thoroughly in the talk titled: 'Applications of Recent Research in Landscape Irrigation Management', by Dave Shaw.

Nutrition Notes

The following list gives a general description of characteristics associated with each element.

- ❖ Number range (percentage or ppm) gives approximate nutrient concentrations for healthy plants. This should serve only as a general guideline since plants can differ dramatically in nutrient requirements.
- ❖ Nutrient Interactions (Toxicity) - describes possible deficiencies of other elements if said element is available in high quantities.
- ❖ Nutrient Interactions (Deficiency) – lists other elements, which when in high quantities, may induce deficiencies of said element.

Nitrogen (N) – mobile (1.0-6.0%)

Deficiency Symptoms

Mild. Uniform yellowing and senescence of older leaves.

Severe. Canopy chlorotic, plants stunted.

Soils

- ❖ Waterlogged; anaerobic; leached sandy soils may be nitrogen deficient.

Nutrient Interactions

Toxicity. NH_4^+ - competes with K, Ca, Mg. Ammonium uptake is optimum at neutral pH and uptake decreases at lower soil pH. Symptoms of ammonium toxicity include leaf necrosis, stem lesions and stunted root and shoot growth.

NO_3^- - competes with P and S. Nitrate uptake is optimum between pH 4.5 and 6.0.

Phosphorus (P) – mobile (0.2-0.5%)

Deficiency Symptoms

Mild. older leaves turn dark green to purple. Stems of herbaceous plants become dark red.

Severe. older leaves dark purple necrotic spots.

Soils

- ❖ pH. Precipitates with Fe (low pH) or Ca (high pH), inducing deficiency of Fe and P or Ca and P, respectively.
- ❖ Cold, wet soils induce P deficiency

Nutrient Interactions

Toxicity. P competes with Fe, Zn, and Cu.

Deficiency. Fe, Zn, Al, and Ca compete with P.

Potassium (K) – mobile (1.5-4.0%)

Foliar K:N ratio 1:1 considered ideal.

Deficiency symptoms

Mild. chlorosis and necrosis develop initially on leaf margins of 2nd and 3rd oldest leaves. Monocots exhibit orange-tan speckling.

Fruit and flower quality decrease (shorter shelf-life).

- ❖ Treatment - fertilizer (soil + foliar) effective only on newer leaves. Older necrotic leaves will not recover.

Soils

- ❖ Sandy, acid soil; organic soil; peat-based mix.

Nutrient Interactions

Toxicity. K competes with Ca and Mg.

Deficiency. Ca and Mg compete with K.

Calcium (Ca) – immobile (0.5-1.5%)

Foliar Ca:Mg ratio of 2:1 and K:Ca ratio of 4:1 considered ideal

Deficiency Symptoms

Mild. New leaves chlorotic, deformed, stunted.

Severe. Leaf necrosis, meristem dies.

Problematic Situations

- ❖ Dry soils, erratic irrigation.
- ❖ High humidity, which reduces transpiration.

Nutrient Interactions

Toxicity. Ca competes with Fe, Mn, Zn, Cu.

Deficiency. K and NH_4^+ compete with Ca.

Magnesium (Mg) – mobile (0.15-0.40%)

Foliar Ca:Mg ratios of 2:1 and K:Mg ratios of 8:1 considered ideal.

Deficiency Symptoms

Mild. Interveinal chlorosis of older leaves. Midribs remain green. In monocots, leaf chlorosis is striped.

Severe. Older leaves become necrotic.

Dolomite and MgO - slow release forms for acid soils. Fertilizer (soil + foliar) effective only on newer leaves.

Problematic soils

- ❖ Sandy soils; leached soils; organic media.
- ❖ pH. Low (<4.5) and high (<6.0) pH soil.

Nutrient Interactions

Toxicity. Mg competes with Mn.

Deficiency. K, NH_4^+, Ca, Na and Al (acid soils) compete with Mg.

Sulfur (S) – primarily immobile (0.15-0.50%)

Foliar S:N ratio of 1:14 considered ideal

Deficiency Symptoms

rare – atmospheric S from ocean and pollution.

Mild. Uniform chlorosis of old and new leaves.

Severe. Leaflet tips necrotic, stunted growth.

Problematic soils

- ❖ Nitrogen – high N may cause S deficiency.
- ❖ leaching – excess leaching.

Nutrient Interactions

Toxicity. Atmospheric SO_2 0.5-0.7 S/m^3 causes necrosis of tissue.

Iron (Fe) – immobile (50-75 ppm)

Deficiency Symptoms.

Mild. Interveinal chlorosis of young leaves. Chlorosis of younger leaves with green spots.

Severe. New leaves white or necrotic and stunted.

- ❖ Correctional treatments – Foliar sprays of iron sulfate or Fe chelates. Soils of high pH should be acidified. Acid fertilizers such as NH_4x rather than compounds of NO_3^--N will also reduce soil pH.

Foliar fertilization will be effective, but temporary. Soil must be corrected to prevent continued chlorosis.

Problematic conditions

- Poorly aerated soils; wet soils
- High pH cause "lime-induced chlorosis" = reduced Fe uptake into plant and physiologically unavailable Fe in plant.
- Cool soils, where roots are not actively growing, may induce iron deficiency. Foliar sprays cannot correct chlorosis caused by cool soils. Once soils warm, new leaves will emerge healthy.

Nutrient Interactions

Toxicity. Excessive Fe in flooded soils – brown speckling on leaves – seen in rice.

Deficiency. Ca (high pH), P, B, Cu, Mn compete with Fe.

Manganese (Mn) – immobile (10-200 ppm)

Deficiency Symptoms.

Mild. varies among plant species*.* Chlorosis between veins of older leaves.chlorosis*.* "Frizzletop" in palms. Gray speckling at base on leaf bladed in monocots.

- Correctional treatments – Foliar sprays of manganese sulfate or Mn chelates will correct the chlorosis.

Special notes:

Soils

- acid soils (pH $<$5.4) may cause Mn toxicity

Environment

- Cold temperatures will induce Mn deficiency for some palms growing outside the recommended regions of culture. Chlorosis caused by cool soils cannot be corrected by foliar sprays. Once soils warm, new leaves will emerge healthy.

Nutrient Interactions

- Toxicity. Excessive Mn may induce symptoms of Fe, Zn, Cu, and/or Ca deficiencies. In acid soils, Mn toxicity appears as marginal yellowing of young leaves with central green area and black speckling in leaves and stems "measles".
- Deficiency. Excessive fertilization with Mg, Ca, or K may induce Mn deficiency.

Copper (Cu) – immobile (2-20 ppm)

Deficiency Symptoms.

New leaves emerge stunted and necrotic, especially near the leaf tips. In monocots, young leaf tips will turn white.

Special notes:

Soils

- Peat soils tightly bind Cu and therefore are more likely to induce Cu deficiencies

Nutrient Interactions

- Toxicity. Copper containing fungicides can induce Cu toxicity. Excessive Cu may induce symptoms of Fe deficiency. Root growth stunted.
- Deficiency. Excessive fertilization with Mn or Fe may induce Cu deficiency.

Boron (B) – immobile. (~20ppm)

Deficiency Symptoms.

Stunted growth and dieback of apical meristem followed by sprouting of lateral stems. Cracked roots and necrosis of meristems.

Soils and Waters

- Boron is often easily leached from soils in areas of regular rainfall. However, in dry desert regions, boron may accumulate to high concentrations.
- Boron levels above 5 ppm in water is toxic to many crops, causing symptoms of leaf tip necrosis

Nutrient Interactions

- Toxicity. Since B is required in such small quantities, B toxicity can easily occur with over fertilization.

Zinc (Zn) – immobile. (15-50 ppm)

Deficiency Symptoms.

Interveinal chlorosis and yellow mottling of new leaves. Decreased stem growth, which appears as rosetting of terminal leaves.

Special notes:

Nutrient Interactions

- Toxicity. High Zn in soil ($>$200 ppm) may induce Fe, Mn or P deficiencies.
- Deficiency. High concentrations of Cu, Ca, Mg and Fe may induce Zn deficiency.

Molybdenum (Mo) – (0.15-0.30 ppm)

Deficiency Symptoms.

Older then younger leaves become chlorotic to yellow-green and leaf margins will roll in. In severe cases, leaf lamina will not develop, leaving only the leaf midrib. "Whiptail" in Brassicas.

Soils

- Sandy acid-leached soils may be Mo deficient

Nutrient Interactions

- Deficiency. Excess sulfates may induce Mo deficiency.

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STUDIES ON GLASSY-WINGED SHARPSHOOTER MANAGEMENT

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NOTES:

EFFECTS OF CULTURAL PRACTICES ON A PUTTING GREEN UNDER SIMULATED TRAFFIC

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Fertilizing with N and K, aerifying, and vertical mowing are common practices on golf putting greens. Each practice and the combinations may have an effect on traffic tolerance.

A sand root-zone putting green was seeded in June, 1999 with 'Cobra' creeping bentgrass (*Agrostis palustris* var. 'Cobra'). Treatments began on July 5, 2000. Treatments are replicated four times in a random complete block design.

Traffic is applied with a self-propelled golf-traffic simulator. The traffic simulator is constructed of differential slip rollers textured with scarified steel hemispheres (notched carriage bolt heads). Traffic is applied to all plots at the equivalent rate of 50,000 rounds per year.

N K	**N K vm**	**K vm**	**N vm cc**	**N**	**K vm cc**	**N K cc**	**control**
vm	**K**	**N K vm cc**	**K cc**	**vm cc**	**N vm**	**N cc**	**cc**
K vm	**vm**	**N vm**	**N K vm**	**K vm cc**	**vm cc**	**N vm cc**	**N cc**
cc	**control**	**N K cc**	**K**	**N**	**N K vm cc**	**N K**	**K cc**
N K	**N vm**	**N K cc**	**K cc**	**N**	**vm**	**N vm cc**	**K vm cc**
K vm	**vm cc**	**N K vm cc**	**N cc**	**control**	**N K vm**	**K**	**cc**
vm cc	**N K vm cc**	**N K cc**	**N vm**	**vm**	**cc**	**K cc**	**N vm cc**
N K vm	**control**	**K**	**N cc**	**K vm cc**	**K vm**	**N K**	**N**

N

N = nitrogen @ 8.0 lbs./M/yr.
K = potassium @ 8.0 lbs./M/yr.
cc = core cultivation @ 3X/yr.
vm = vertical mow @ 3X/yr.
Plots with no N treatment received 2.0 lb.N/M.
All plots received traffic

Mean visual quality July-00 - Jan-01

Low N		**High N**	
Treat.	**Quality**	**Treat.**	**Quality**
K	5.4	N vm	6.1
check*	5.4	N K cc	6.1
vm	5.2	N K vm	6.1
K cc	5.2	N K	6.0
K vm	5.1	N cc	6.0
cc vm	5.0	K cc vm	6.0
K cc vm	5.0	N	5.9
cc	4.9	N cc vm	5.8
LSD	**0.3**		**0.2**

Mean clipping yields July-00 – Jan-01

Low N		**High N**	
Treat.	**g/m²/d**	**Treat.**	**g/m²/d**
cc	2.4	NKccvm	3.3
K	2.3	N cc	3.2
cc vm	2.2	N	3.1
K vm	2.0	N vm	3.1
check*	1.9	N K	2.9
K cc	1.9	N K cc	2.8
vm	1.9	N K vm	2.8
K cc vm	1.7	N cc vm	2.7
LSD	**0.6**		**0.6**

*check received low N.

Mean visual quality Mar-01 – Jul 01

High N	K vm	6.4
	K cc	6.3
	vm	6.3
	K cc vm	6.2
	K	6.2
	cc	6.0
	N	6.0
	cc vm	5.9
Low N	check (low N)	5.0
	K	5.0
	K vm	4.9
	vm	4.8
	K cc	4.6
	cc vm	4.6
	K cc vm	4.5
	cc	4.5
LSD		**0.3**

Mean clipping yields Mar-01 – Jul-01($g/m^2/d$)

High N	K cc vm	2.9
	cc	2.6
	vm	2.6
	K vm	2.5
	K	2.5
	N	2.4
	cc vm	2.4
	K cc	2.3
Low N	K	0.9
	cc	0.8
	K cc vm	0.8
	K vm	0.8
	cc vm	0.7
	check (low N)	0.7
	K cc	0.7
	vm	0.7
LSD		**0.4**

Very little thatch has accumulated in the green due to the traffic. The study shows that bentgrass under traffic needs nitrogen for performance. Of the treatments, nitrogen has the predominant effect, but nitrogen alone did not rate highest or yield highest. Combined with potassium, nitrogen was consistently among the highest. Under low N the mechanical treatments, especially core cultivation were visually rated lowest in the July to January period, probably due to slow injury recovery from the treatment. In the March to July period, the combination of K and vertical mowing were rated in the highest group.

APPLICATIONS OF RECENT RESEARCH IN LANDSCAPE IRRIGATION MANAGEMENT

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Urban landscapes planted with turfgrasses, groundcovers, shrubs, and trees provide numerous functional, recreational, and aesthetic benefits. Southern California has a Mediterranean climate, characterized by long, hot, dry summers, thus landscapes must be irrigated during the summer to maintain their benefits. The amount of water applied to landscapes in southern California is estimated to be 25% to 30% of all water used in the region. Applied research on the irrigation needs of landscape plant materials is limited, but application of recent research findings should still make significant landscape water conservation possible.

The water use of a planted area is a function of water lost through plant transpiration and water evaporating from the soil surface in a process known as *evapotranspiration* (ET). Reference evapotranspiration (ET_0) is the amount of water used by 6-inch tall cool-season turfgrass when it is given unlimited water; it is *not* the amount that cool-season turfgrass actually needs for adequate performance, however. Field studies on landscape plants' water needs have relied on applying various percentages of ET_0 and then measuring plant response.

For example, water conservation field studies in the early 1980's on turfgrasses demonstrated that water savings of 30% for cool-season turfgrasses and 40% for warm-season turfgrasses were attainable without significant loss of quality. More recent studies with established plantings of six widely-used species of groundcovers indicated that, although the response to irrigation treatment was species dependent, coyote bush (*Baccharis pilularis*), ice plant (*Drosanthemum hispidum*), and English ivy (*Hedera helix*) maintained at least minimally acceptable visual quality with irrigation equal to 20% ET_0. In addition, periwinkle (*Vinca major*) required 30% ET_0. Cinquefoile (*Potentilla tabernaemontanii*) appears to need irrigation at about 75% ET_0, while *Gazania* was unable to maintain acceptable long-term visual quality at any irrigation amount. It appears that many, but not all, groundcovers have minimum irrigation needs similar to or less than those of warm-season turfgrasses. Similar studies on minimum water needs of established shrubs and trees have indicated that as with groundcovers, their responses to irrigation treatment are species dependent, but many perform well when irrigated as low as 35% ET_0.

In order to apply these findings for water conservation, irrigation managers, landscape architects, and others must consider four items:

1. Understand there is very limited research-based information on landscape plants' water needs, recognize the limitations of using ET_0 as the basis for estimating water use in a landscape, and understand the difference between a plant's water *use* and a plant's water *need*.

2. Directly measure the performance specifications of the irrigation system (e.g. precipitation rate, uniformity, efficiency, etc.).

3. Access and use local historical and/or current (real-time) ET_0 data to schedule irrigations.

4. Know how to put all of the above information and data together mathematically to calculate an appropriate irrigation schedule.

NOTES:

USING RESPIRATION MEASUREMENTS TO PREDICT GROWTH AND LOW-TEMPERATURE TOLERANCE OF TURFGRASSES

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All organisms respire (breakdown sugars and/or fats) to produce chemical energy to function and grow. As they respire they give off heat, which is a loss of energy. If a plant has a high respiration rate without losing much energy as heat it is functioning and growing efficiently (using the energy for growth instead of losing it as heat). If, on the other hand, a plant has a low respiration rate and is losing high amounts of heat it is not functioning or growing efficiently. In some cases a plant may lose more energy as heat than it is using for growth; if this continues for too long the plant will die. The work that is just getting under way here utilizes a calorimeter to make simultaneous and accurate measurements of energy used for growth (respiration) and energy lost (heat) in plants. These calorespirometric measurements will be used to predict optimum growing conditions and the responses of turfgrasses to their environment. This laboratory research may provide a method of predicting optimum growing conditions (temperature, water availability, fertility level, salt tolerance, etc.) for plants without having to grow the plants in varying conditions for long periods of time to determine how they respond.

The calorimeter may also be useful in predicting low-temperature tolerance in plants. When water freezes it gives off heat (heat of fusion) that can be measured in the calorimeter. By programming the calorimeter to slowly lower its temperature from just above freezing to several degrees below freezing the temperature at which tissues in the calorimeter freeze can be determined. This may be helpful in predicting low-temperature tolerance for existing and newly developed turfgrass varieties as well as for other landscape plants.

NOTES: